

Related to other papers in this special issue	9 (p87); 6 (p56); 21 (p208); 28 (p276)
Addressing FAIR principles	F, A, I, R

The FAIR Funding Model: Providing a Framework for Research Funders to Drive the Transition toward FAIR Data Management and Stewardship Practices

Margreet Bloemers^{1†} & Annalisa Montesanti²

¹The Netherlands Organization for Health Research and Development (ZonMw), 2509 AE, The Hague, The Netherlands

²Health Research Board (HRB), Dublin 2, DO2 H638, Ireland

Keywords: FAIR funder; Data stewardship; Data management plan (DMP); Policy; Tools

Citation: M. Bloemers & A. Montesanti. The FAIR funding model: Providing a framework for research funders to drive the transition toward FAIR data management and stewardship practices. *Data Intelligence* 2(2020), 171–180. doi: 10.1162/dint_a_00039

ABSTRACT

A growing number of research funding organizations (RFOs) are taking responsibility to increase the scientific and social impact of research output. Also reusable research data are recognized as relevant output for gaining impact. RFOs are therefore promoting FAIR research data management and stewardship (RDM) in their research funding cycle. However, the implementation of FAIR RDM still faces important obstacles and challenges. To solve these, stakeholders work together to develop innovative tools and practices. Here we elaborate on the role of RFOs in developing a FAIR funding model to support the FAIR RDM in the funding cycle, integrated with research community specific guidance, criteria and metadata, and enabling automatic assessments of progress and output from RDM. The model facilitates to create research data with a high level of FAIRness that are meaningful for a research community. To fully benefit from the model, RFOs, research institutions and service providers need to implement machine actionability in their FAIR RDM tools and procedures. As many stakeholders still need to get familiar with “human actionable” FAIR data practices,

[†] Corresponding author: Margreet Bloemers (E-mail: Bloemers@zonmw.nl, ORCID: 0000-0003-3710-3188).

the introduction of the model will be stepwise, with an active role of the RFOs in driving FAIR RDM processes as effectively as possible.

1. INTRODUCTION: THE FUNDERS' VIEW ON FAIR DATA ENHANCING RESEARCH IMPACT

Increasingly, research funding organizations (RFOs) require grant holders to deliver reusable data as output from their research projects, and to share their data to contribute to future research. It is nowadays widely accepted that the FAIR principles [1], new practices for research data management and stewardship (RDM), and data management plans (DMP) are essential elements in creating reusable data, and optimizing data sharing. In this way, RFOs want to ensure that public funding is invested efficiently, and allows a good return on the investment. Data created in research projects should be made generally available with as few restrictions as possible, and where ethical and legal obligation permit, enabling secondary use wherever possible instead of creating new data.

1.1 The Rationale for Health Research

In this paper we focus on the perspective from health RFOs on FAIR RDM in the funding cycle. It is a current issue for health RFOs such as the Netherlands Organization for Health Research and Development (ZonMw)^①, Health Research Board (HRB)^②, Ireland, and the Association of Dutch Health Foundations, as well as other members of the Ensuring Value in Research (EViR) Funders' Collaboration and Development Forum. These and other health RFOs strongly recognize the need for reusable data and data sharing, which eventually contribute to scientific and societal impact of research through the use of valuable evidence in research, policy and practice and, ultimately, improvement in public health. Moreover, reusing and sharing data may advance new research methods and enable research into topics that would otherwise remain unexplored (e.g., rare diseases, and personalized medicine (ZonMw's FAIR genomes guidelines^③), accelerate the research response in public health emergencies (e.g., infectious diseases [2]), and allow answers to policy and practice relevant questions (e.g., through HRB's Secondary Data Analysis Projects^④).

The importance of creating reusable data finds further anchoring in the Guiding Principles^⑤ of the EViR Funders Forum (started in 2017). This group of health RFOs aims at the reduction of research waste and increase of research reproducibility and generally the value of health research. For instance, ZonMw developed a so-called Fostering Responsible Research Practices Framework [3] for the planning, monitoring

^① <https://www.zonmw.nl/en/>.

^② <https://www.hrb.ie/>.

^③ <https://www.zonmw.nl/nl/onderzoek-resultaten/geneesmiddelen/programmas/project-detail/personalised-medicine/fair-genomes-a-national-guideline-to-promote-optimal-reuse-of-ngs-data-in-research-and-healthcare/>.

^④ <https://www.hrb.ie/funding/funding-schemes/all-funding-schemes/grant/secondary-data-analysis-projects-sdap-2019/>.

^⑤ <https://sites.google.com/view/evir-funders-forum/guiding-principles>.

and evaluation of its programs and projects. FAIR RDM is an integral part of the framework, amongst many other elements.

1.2 Carrot and Stick

Integrating FAIR RDM into good research practice requires a joint effort from researchers, their institutions and research communities, service providers and RFOs. Obstacles emanating from one or more of these stakeholders have an effect on FAIR RDM as a whole. On the other hand, stakeholders who apply “carrots and sticks” may strongly encourage researchers to create and/or share FAIR data in their projects. RFOs in particular can be strong drivers when they combine their funding requirements and funding policies (“stick”) with guidance and financial support (“carrot”) for researchers to incorporate tools and standards that fit their research objectives and make their data FAIR. In this way, RFOs also encourage research institutions to improve facilities and support for their researchers to create FAIR data, as they need to comply with the funder’s requirements.

2. THE CURRENT SITUATION AND ITS CHALLENGES

Having set the ambition, the reality is instead much more complex. FAIR RDM is developing as one of the pillars of open science. The current transition of “science” to “open science” requires a cultural change throughout all levels of academic organizations. This includes for instance educating scientists [4], a change in rewarding their output, and opening opportunities for scientists to share research output with parties outside academia [5, 6]. The transition is also a technological change, requiring the implementation of new guidelines and practices, anchored in corresponding policies [7].

In most countries, however, the integration of FAIR RDM in daily research practice still faces important obstacles and challenges caused by different perceptions of its relevance, conflicting interests and regulations, reluctance or restrictions to make data either FAIR or open [8], and a lack of expertise, (findable) services, and finance. From our experience, these challenges include the following issues and parties.

Researchers are not well prepared or supported:

- Many researchers are not yet familiar with the FAIR principles, or what they mean. Also the concept of machine readable (actionable) information is not known, nor are the practices and tools available;
- Researchers fear that the RFOs requirements lead to additional costs and therefore a reduction of research budget;
- Some researchers perceive the RDM requirements as additional paperwork, from which their research does not directly benefit.

RFOs are often not ready to turn their ambitions into reality:

- They lack expertise, skillset and resources to review DMPs and assess their quality and compliance;

- There is a lack of incentives for researchers to create FAIR data, share data and achieve societal impact, as most RFOs and research institutions still judge researchers solely by their publications and citation.

Research institutions are often not sufficiently equipped to support RDM:

- They lack expertise and skillset for the new profession of data stewards to support and guide their research teams;
- Many tools, software and standards for making FAIR data a reality are still under development, not known, or not widely implemented;
- In general, there is no agreement among the parties about the responsibility for financing data stewardship after a research project to keep data available for reuse.

These challenges should be of serious considerations for RFOs who want to introduce new RDM requirements and implement them effectively. The ability to overcome the challenges determines whether it is feasible for researchers to comply with the requirements. It is extremely important for RFOs, research institutions, as well as researchers to acknowledge that creating FAIR data and preparing DMPs is not a goal in itself, but a prerequisite for high quality research, leading to scientific and societal impact.

3. FUNDERS' INITIATIVES TO IMPROVE FAIR DATA PRACTICES

To promote FAIR data, many RFOs have integrated into their research funding cycle requirements for RDM planning (DMP), reviewing DMPs, monitoring the progress of RDM, and evaluating the output from RDM at the end of a project. Increasingly, RFOs demand that DMPs comply with (a number of) FAIR principles, with the aspiration that the data need to be as FAIR as possible to be reusable. Moreover, some RFOs are considering (additional) requirements with respect to certain aspects of FAIRness: i.e., promote that researchers develop and apply (machine actionable) metadata, or standards that are commonly used within their research community to improve the interoperability of their research data [9].

Initiatives of RFOs to solve some of the hurdles that limit FAIR RDM in practice include the following examples.

To create awareness or educate:

- HRB organized activities to educate and increase awareness among researchers through workshops on data management and stewardship practices and the FAIR principles.
- HRB ran a program to upskill research support professionals (e.g., librarians, data managers) in research institutions to create the first data stewards in Ireland.
- ZonMw funded the development of a data steward profession description for life sciences [10]. It forms the basis for the international harmonization of training and profiling of data stewards. See also the paper of Hugh et al. in this special issue [4].

In funding schemes:

- HRB introduces new practices for FAIR RDM as pilots in some funding schemes^⑥, aiming to explore the resources, awareness and knowledge, tools and process for FAIR RDM in funded research.
- The Canadian Institutes of Health Research (CIHR)^⑦ provides supplemental funding^⑧ for research applying the FAIR principles and making use of existing clinical data sets.
- The ZonMw's call for "Tackling antibiotic resistance by reusing data and increasing FAIRness"^⑨ requires applicants to set up a research plan with existing data, and improving the quality and sustainability of these data through FAIRification. See also the paper of Jacobsen *et al.* in this special issue [11].

On the policy side of RFOs:

- RFOs are developing policies, procedures and guidelines that have a good balance of "carrots and sticks". Take for example the guidelines of ZonMw^⑩ or the Association of Dutch Health Foundations^⑪, and the new data policy of HRB.
- ZonMw is implementing a new approach to organize RDM together with data stewards of Dutch research institutions and data service organizations. Also other RFOs are getting involved, such as the Dutch health foundations. The new approach starts from the responsibility for good quality RDM and DMP at the researchers, their research institutions and data stewards. ZonMw as a RFO only sets the requirements and evaluates the outcome with the use of a number of key items^⑫. Further development of this approach will allow tailoring of RDM requirements to the needs and feasibility within a research community to achieve a certain level of FAIRness of research data.
- RFOs and research institutions associated in Science Europe have together achieved international alignment of research data management [12], to set requirements for a DMP template and criteria for the selection of data repositories. Harmonizing requirements, criteria and templates will simplify the work for researchers and data stewards. See also the paper of Jones *et al.* in this special issue [13].
- There is a growing awareness among RFOs and research institutions of the need for incentives for researchers and valuing their efforts for FAIR data. This topic is on the agenda of the European Open

^⑥ <https://blog.hrbopenresearch.org/2019/03/29/fair-data-management-a-new-funding-requirement-but-a-pre-existing-research-necessity/>.

^⑦ <http://www.cihr-irsc.gc.ca/e/193.html>.

^⑧ <https://www.researchnet-recherchenet.ca/rnr16/vwOpprtntyDtIs.do?prog=2999&view=currentOpps&type=EXACT&resultCount=25&sort=program&next=1&all=1&masterList=true#objective>.

^⑨ <https://www.zonmw.nl/nl/onderzoek-resultaten/gezondheidsbescherming/resistentie/>.

^⑩ <https://www.zonmw.nl/en/research-and-results/fair-data-and-data-management/>.

^⑪ <http://www.gezondheidsfondsen.nl/wordpress/wp-content/uploads/2019/07/Standpunt-Open-science-juli-2019.pdf>.

^⑫ https://www.zonmw.nl/fileadmin/zonmw/documenten/Toegang_tot_data/Key_items_overview_short_guidance_versie_1.0_text_file.pdf.

Science Cloud® and various national open science platforms (e.g., the National Open Science Platform® in the Netherlands, and the National Open Research Forum® in Ireland).

- The HRB new policy on management and sharing of research data applying to all HRB-funded research where data are generated as a fundamental output of the research project.

Although these initiatives may help to improve the FAIR RDM related functions in the funding cycle (planning, reviewing, monitoring, evaluating and promoting FAIR standards and machine actionable metadata), RFOs are not necessarily the party with the optimal or appropriate expertise. The next step is therefore that RFOs engage with other stakeholders in RDM to define the necessary tasks, and to re-allocate responsibilities (similar to the policy change of ZonMw as described above). In addition, we note that implementation of new tools for RDM [14] is crucial to support researchers and data stewards in their RDM activities.

4. TOWARD A NEW MODEL FOR FAIR FUNDING

In 2018, the GO FAIR International Support and Coordination Office in the Netherlands brought together a number of pioneering research parties and service providers to design the FAIR funding model [9]. HRB and ZonMw are currently the main participating RFOs in this initiative. The model is designed to provide a framework in order to integrate multiple opportunities and innovative tools to support the RDM related functions of the funding cycle, together with tailored guidance for researchers [13, 14]. It is unique in its potential to tailor FAIR RDM to create data with a level of FAIRness that is in line with the needs and feasibility of a research community or domain, and requirements of the RFO [11].

In this way, the model provides solutions for hurdles in DMP planning, reviewing and evaluation, thereby facilitating RDM practices in all stages of the research process. Moreover, the model supports the creation of interoperable research data that are meaningful for a research community. It thereby supports researchers to create data with a high level of FAIRness, as well as the ambition of RFOs to gain high impact from research output.

⑥ <https://www.eosc-portal.eu/>.

⑥ <https://www.openscience.nl/en/themes/recognizing-and-assessing-researchers>.

⑥ <http://norf-ireland.net/>.

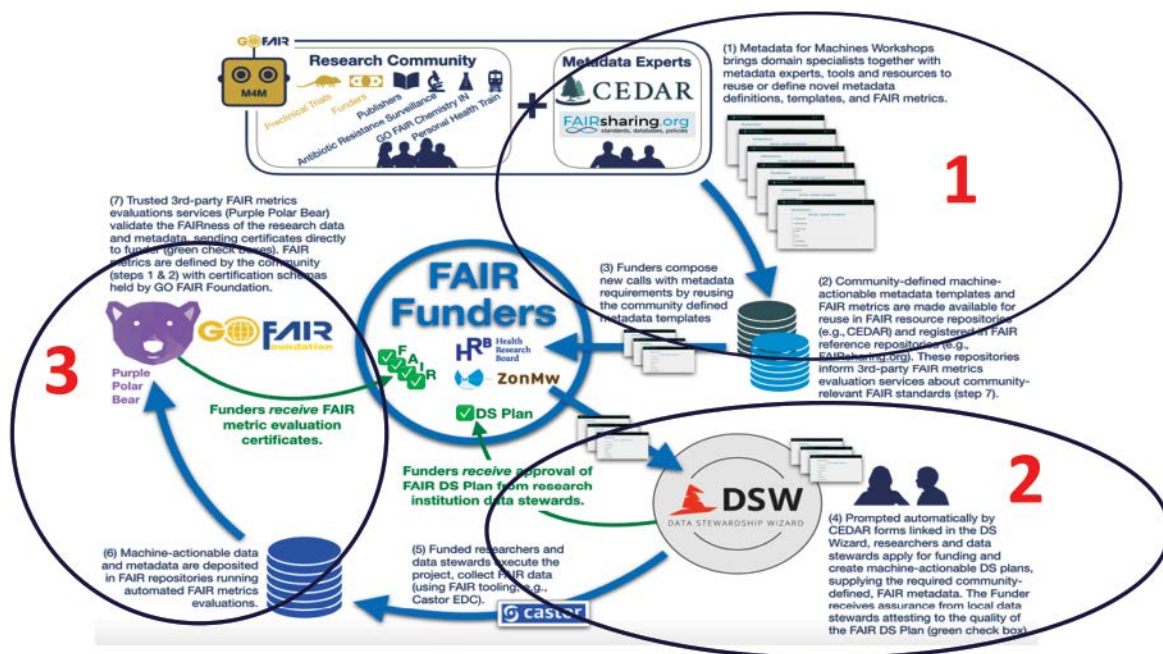


Figure 1. The FAIR funding model integrates tools to support the functions in the funding cycle. Note: In area (1) tools guide researchers to community specific services, metadata and standards. RFOs can promote researchers to use them, and to extend the list of community specific metadata if appropriate ones are not yet available [15]. In area (2) the tools support DMP planning, tailored to the topic of the research project, and the requirements of the RFO. Finally, in area (3) are the tools to assess the quality of RDM and to assess the level of FAIRness of the data set that is achieved. These tools may serve in various phases of the funding cycle to assess the progress of RDM planning, execution, and the final research output. The stakeholders mentioned in the model are pioneers who develop elements of the model, and show case its functioning in practice. The elements may also be provided by other stakeholders.

4.1 Machine Actionable Data and Services

The central feature to make the FAIR funding model function is the automatic exchange of information through the use of machine actionable (“computer readable”) metadata, FAIR data points, and linkage with institutional information systems, tools for planning RDM, and for evaluation. This allows different kinds of stakeholders to engage in the realization of FAIR RDM, and end users to benefit from an integrated system of tools and services.

A similar approach has been proposed in this issue by Arne Waalkens and co-authors, pointing at the need for “FAIR as a Service”, making use of machine actionable interaction to benefit from the integration of public and commercial data [16].

5. NEXT STEPS

The full potential of the FAIR funding model relies on the ability and willingness of RFOs, research institutions and service providers to implement machine actionability in their FAIR RDM tools and procedures. At present, the stakeholders in the scheme are continuing the technical development and piloting of the model's elements. Through the introduction of machine actionability as a key feature of the model, the FAIR funding model is open to connect with any new tool or standard that stakeholders develop and pilot. Wellcome Trust, for example, is exploring the possibility of developing an automatic evaluator to assess the planning and outcome of RDM in research projects[®].

RFOs such as ZonMw, HRB, and the Association of Dutch Health Foundations are aiming to introduce (elements of) the FAIR funding model to support their new funding policy. Therefore, they still need to assess the technical aspects to allow connection of their institutional tools to elements of the FAIR funding model. A collaboration in a fair service consortium as suggested by Waalkens and co-authors may help to broaden the research community involved, and to accelerate this development [16].

Apart from these technological steps, the most challenging step is to educate the researchers and data stewards to incorporate FAIR RDM in their work, and benefit from the tools and services. At present, many of them still need to get familiar with the FAIR principles and start to apply them in a "human actionable" way. Moreover, researchers and their institutions need to get acquainted with tools and services to arrange their RDM according to ethical and legal obligations, and get confidence that their data and intellectual property are protected properly [8].

Taken together, for the realization of the FAIR funding model all stakeholders need to take responsibility and quite some efforts. These efforts will be weighed with the benefits they expect from the model.

Considering the interest of the RFOs in gaining impact and valuing the reuse and sharing of research data, together with their influence on researchers through their funding requirements, RFOs can take an active role in driving FAIR RDM processes as effectively as possible. For this, the FAIR funding model promises to provide a strong backbone to integrate the FAIR principles with essential tools and practices.

AUTHOR CONTRIBUTIONS

M. Bloemers (bloemers@zonmw.nl) and A. Montesanti (AMontesanti@hrb.ie) conceived and presented the idea relevant to the FAIR funders model and the Dutch and Irish perspectives, respectively. M. Bloemers is the main author of the manuscript.

[®] <https://wellcome.ac.uk/sites/default/files/FAIR-checking-software-request-for-information.pdf>.

ACKNOWLEDGEMENTS

We thank Mira Staphorst of the Dutch Heart Foundation and her colleagues of the Association of Dutch Health Foundations, Jeremy Geelen of the Canadian Institutes of Health Research, and Kate Holmes of the Stroke Association for their input to the article.

REFERENCES

- [1] M.D. Wilkinson, M. Dumontier, I.J. Aalbersberg, G. Appleton, M. Axton, A. Baak, ... & B. Mons. The FAIR guiding principles for scientific data management and stewardship. *Scientific Data* 3(2016), Article No.160018. doi: 10.1038/sdata.2016.18.
- [2] GLOPID-R: Roadmap for data sharing in public health emergencies (2019). Available at: <https://www.glopid-r.org/wp-content/uploads/2019/06/glopid-r-roadmap-for-data-sharing.pdf>.
- [3] ZonMw: Strengthening Impact in The Netherlands. The case of ZonMw (2018). Available at: https://gallery.mailchimp.com/7fa42547078f2cac7d96896f5/files/54710d19-6a40-4f27-a8c9-c3a15a010a59/Wendy_paper.pdf.
- [4] P. Ayris, A.L. de San Román, K. Maes & I. Labastida. Open science and its role in universities: A roadmap for cultural change. League of European Research Universitie (LERU). Advice paper 24 (2018). Available at: <https://www.leru.org/files/LERU-AP24-Open-Science-full-paper.pdf>.
- [5] M. Ball, M. Bloemers, D. Carr, V. Cavalli, M. Haglund, V. Kalaitzi, ... & K. Vandeveld. A vision for open science. In: The workshop “Research Institutions and Libraries and the role of Funders in the European Open Science Cloud” held at the LIBER 2018 Conference in Lille, France on 4 July 2018. doi: 10.5281/zenodo.1491303.
- [6] European Commission: Turning FAIR into reality. Final report and action plan from the European Commission expert group on FAIR data (2018). doi: 10.2777/1524.
- [7] A. Landi, M. Thompson, V. Giannuzzi, F. Bonifazi, I. Labastida, L.O. Bonino da Silva Santos & M. Roos. The “A” of FAIR – as open as possible, as closed as necessary. *Data Intelligence* 2(2020), 47–55. doi: 10.1162/dint_a_00027.
- [8] A. Jacobsen, R. de Miranda Azevedo, N. Juty, D. Batista, S. Coles, R. Cornet, ... & E. Schultes. FAIR principles: Interpretations and implementation considerations. *Data Intelligence* 2(2020), 10–29. doi: 10.1162/dint_r_00024.
- [9] S. Scholtens, P. Anbeek, J. Böhmer, M. Brullemans, M. van der Geest, M. Jetten, ... & C. van Gelder. Towards a community-endorsed data steward profession description for life science research (2019). doi: 10.5281/zenodo.2554974.
- [10] A. Jacobsen, R. Kaliyaperumal, L.O. Bonino da Silva Santos, B. Mons, E. Schultes, M. Roos & M. Thompson. A generic workflow for the data FAIRification process. *Data Intelligence* 2(2020), 56–65. doi: 10.1162/dint_a_00028.
- [11] Science Europe: Practical guide to the international alignment of research data management D/2018/13.324/4 (2018). Available at: https://www.scienceeurope.org/wp-content/uploads/2018/12/SE_RDM_Practical_Guide_Final.pdf.
- [12] S. Jones, R. Pergl, R. Hooft, T. Miksa, R. Samors, J. Ungvari, R.I. Davis & T. Lee. Data management planning: How requirements and solutions are beginning to converge. *Data Intelligence* 2(2020), 208–219. doi: 10.1162/dint_a_00043.

- [13] M. Thompson, K. Burger, R. Kaliyaperumal, M. Roos & L.O. Bonino da Silva Santos. Making FAIR easy with FAIR tools: From creolization to convergence. *Data Intelligence* 2(2020), 87–95. doi: 10.1162/dint_a_00031.
- [14] P. Wittenburg, H.P. Sustkova, A. Montesanti, S.M. Bloemers, S.H. de Waard, M.A. Musen, ... & E.A. Schultes. The FAIR Funder pilot programme to make it easy for funders to require and for grantees to produce FAIR data. arXiv preprint. arXiv: 1902.11162, 2019.
- [15] H. van Vlijmen, A. Mons, A. Waalkens, W. Franke, A. Baak, G. Ruiter, ... & J.-M. Neefs. The need of Industry to go FAIR. *Data Intelligence* 2(2020), 276–284. doi: 10.1162/dint_a_00050.